1 Introduction

"All problems are finally scientific problems."

G. B. Shaw 1856–1950

Life on Earth has developed under permanent exposure to radiation. In addition to ionizing radiation from natural sources a multitude of exposures from artificial sources produced by mankind came into play in the twentieth century. These radioactive sources have been introduced and used in the course of the rapid development of medical diagnostics and therapy and natural science and technology.

Humans have no senses for ionizing radiation. Therefore, possible risks related to ionizing radiation were often underestimated. Even today it happens quite frequently that strong radioactive sources, which had been used in medicine or technology and disposed off illegally as scrap metal are 'found', for example, by children. Since no particular danger appears to originate from such sources, they are sometimes handled by the children and even stored in their homes. Considering the strength of radioactive sources used in medicine and technology, the irradiation from these sources over a period of several days can easily lead to radiation sickness and even death.

To judge correctly the potential danger caused by radioactive sources, one has to develop a feeling for the biological effects of ionizing radiation. It is impossible to eliminate radiation exposure altogether. This relates to the fact that one cannot possibly avoid natural radioactivity from the environment. Therefore, additional exposures have to be compared and judged with respect to the natural radiation exposure. To estimate the potential risk from radiation from the environment and from other sources, a minimum knowledge about physics, chemistry, and biology is required which will replace in some sense the missing senses for radioactivity.

Radioactivity was discovered by Henri Antoine Becquerel in 1896, when he realized that radiation emerging from uranium ores could blacken photosensitive paper. Originally it was believed that this was due to some fluorescence radiation from uranium salts. However, the photosensitive paper was also blackened without previous exposure of the uranium ore to light. The radiation spontaneously emerging from uranium was not visible to the human

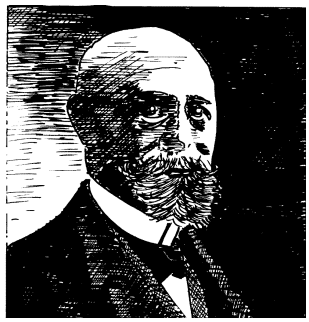


Figure 1.1
Portrait of
Henri Antoine Becquerel
(Drawing: C. Grupen)

Figure 1.2
Portrait of
Wilhelm Conrad Röntgen
(Drawing: C. Grupen)

1896
discovery of radioactivity by Henri Antoine Becquerel

C. Grupen, *Introduction to Radiation Protection*,
Graduate Texts in Physics, DOI 10.1007/978-3-642-02586-0_1,

eye. Therefore, it was clear that one was dealing with a new phenomenon.

1895
discovery of X rays by Wilhelm Conrad Röntgen

In the context of radiation protection also the discovery of X rays by Wilhelm Conrad Röntgen has to be mentioned. This radiation emerged from materials after bombardment with energetic electrons. Actually the discovery by Röntgen in December 1895 had been a factor of stimulating Becquerel to investigate fluorescence radiation from uranium salts.

discovery of polonium and radium

The new research field of radioactivity became particularly important when Marie and Pierre Curie in 1898 succeeded in isolating new radioactive elements (polonium and radium) from pitchblende. Marie Curie was awarded with two Nobel Prizes for her research (1903 Henri Becquerel, Pierre Curie, Marie Curie: Physics Nobel Prize for the discovery and research on radioactivity; 1911 Marie Curie: Nobel Prize for Chemistry for the discovery of the elements polonium and radium by chemical separation techniques from pitchblende).

α, β, γ rays

At the turn of the century (1899–1902) the investigation by Ernest Rutherford clearly demonstrated that there are different types of ionizing radiation. Since initially it was impossible to identify these different types, they were named after the first letters of the Greek alphabet α, β, and γ rays. It could be shown that α and β rays could be deflected by magnetic fields, in contrast to γ rays.

artificial radioactivity
nuclear fission

This radioactivity was a phenomenon of the natural environment. Nobody was able to turn inactive materials into radioactive sources by chemical techniques. Not until 1934 Frederic Joliot and Irène Curie managed to produce new radioactive materials artificially using nuclear physics methods. Only a few years later Otto Hahn and Fritz Straßmann (1938/39) succeeded in inducing fission of uranium nuclei. The intention of Hahn and Straßmann was to produce elements beyond this heaviest naturally occurring element by neutron bombardment. The particular importance of fission was recognized by Lise Meitner and Otto Frisch.

transuranic elements

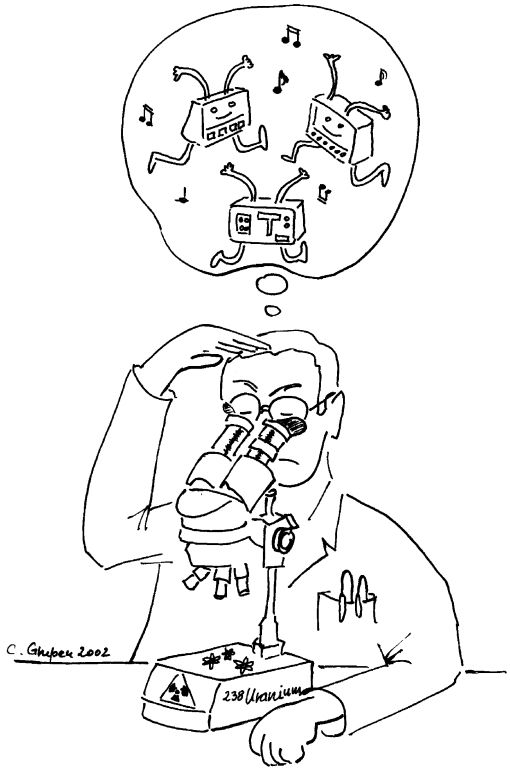
Since then physicists have been trying to produce artificially superheavy elements beyond uranium ('transuranic elements') which do not occur in nature. Most of these elements are highly radioactive. This group also includes the chemically toxic plutonium and americium. Up to now 26 elements which do not occur in the natural environment have been artificially synthesized.

effects of ionizing radiation

The importance of radioactivity and of radiation protection for mankind and the environment is quite substantial. The judgment on the effects of ionizing radiation on humans should not be left only to so-called experts. Everybody who is prepared to get involved in these problems should be in a position to come to his own judgment.

It is highly desirable that, for example, discussions on the benefits and risks of nuclear power are not dominated by emotional antipathy or blind support, but rather by solid facts about radiation and radiation-related effects.

The intention of this book is to introduce the reader into the physical, technical, medical, and legal aspects of radiation. At the same time this book will hopefully contribute to the readers' understanding of the necessary scientific issues, allowing, for example, discussions on nuclear energy with higher objectivity.



Dr. Linkenstein was baffled when he found 'radio-activity' had a literal meaning.